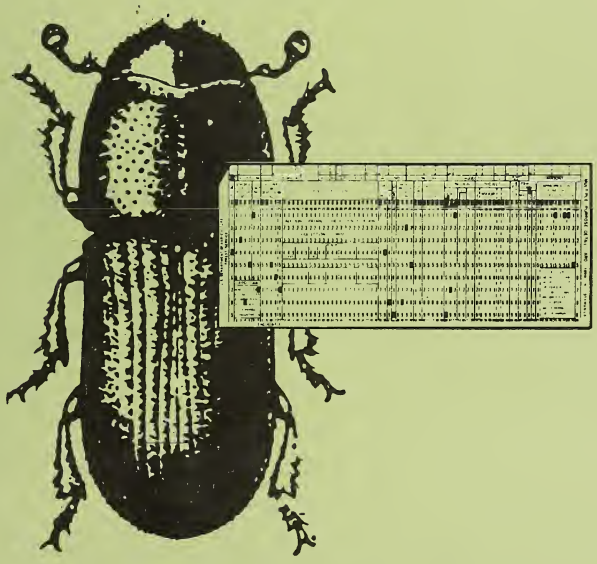
SOUTHERN PINE BEETLE TECHNOLOGY TRANSFER TASK FORCE REPORT



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245

SOUTHERN PINE BEETLE

TECHNOLOGY TRANSFER

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CONTENTS

PREFACE

The southern pine beetle (SPB) problem is one of the most complex protection problems facing southern landowners and forest resource managers. In fact, the traditional notion of protecting the forest once outbreaks have developed may no longer be appropriate. The newer concept of integrated forest pest management is a more dynamic, but untested, approach to dealing with the SPB problem.

Integrated forest pest management (IFPM) requires that efforts to reduce losses from SPB be compatible with total resource management. With IFPM the land manager will also be able to undertake stand management practices that can prevent or limit losses and still permit him to achieve other management objectives; control efforts will not be limited to control reactions after beetle populations reach economically damaging levels.

The Southern Pine Beetle Technology Transfer Task Force was convened in February 1979. The Task Force reviewed research findings from ESPBRAP and assessed the needs and priorities for passing these results on to the appropriate users.

The Task Force found that much of the information needed for first generation IFPM management systems for SPB has been developed. Implementing the new techniques is a high-priority activity that requires teamwork and cooperation on the part of the forest research, pest control, extension, management organizations, and small private landowners.

The members of the Task Force are:

Stan Adams--Director, Office of Information, USDA-Forest Service, R-8

Dick Fitzgerald--Group Leader, Silviculture, USDA-Forest Service, R-8

Thad Harrington--Assistant Director, USDA-Forest Service, Southern Forest Experiment Station

Jim Neal--Regional Extension Forester, Science and Education Administration, Cooperative Extension

Jim Tiner--Management Chief, Arkansas Forestry Commission

Harvey Toko--Staff Director, Forest Insect and Disease Management, USDA Forest Service, State and Private Forestry, Southeastern Area

Fred Trew--Center Leader, Westvaco Corporation

Zeb White--Consulting Forester and President, Zebulon White and Co., Inc.

Dick Williams--Management Forester, Georgia Pacific Corporation

Jack Coster, Chairman and Applications Coordinator, Expanded Southern Pine Beetle Research and Applications Program

This report summarizes the new technology that has resulted from ESPBRAP and what needs to be done to insure its implementation.

JOHN A. VANCE
Area Director

INTRODUCTION

Foresters in the South need no introduction to the southern pine beetle. Outbreaks of the insect have been reported as far back as the 1750's. In the late 18th century and throughout the 19th century, pine beetle outbreaks were reported from North Carolina, Georgia, South Carolina, Texas, West Virginia, Tennessee and Virginia. The beetle had also been found in Oklahoma, Arkansas, Maryland, Pennsylvania, and Florida.

The beetle causes significant pine mortality every year in the South, although the actual amount of timber killed has not been adequately documented and varies considerably from year to year (figure 1). In some years, such as 1974, beetle outbreaks occur throughout the 13-State southern pine region. In other years damage is limited to a few widely scattered locations.

Even within a State the damage caused by the beetles fluctuates widely. In Georgia, for example, the timber volume killed by SPB increased from 3.225 million cubic feet in 1972 to 36.203 million cubic feet only two years later. The location of the outbreak also changed. During 1960-1969, outbreaks in Georgia were found primarily in the northeastern and central areas of the State. From 1972-1976, the outbreaks spread across a wide area, even occurring in some southeastern counties (figure 2).

The implications of the historical data are clear for the forest manager--The SPB problem is not likely to disappear. The fact that specific pine forests in an area have not experienced recent SPB damage does not mean they are immune. The sudden changes in beetle activity that can occur make it difficult for managers to plan and maintain direct control activities.

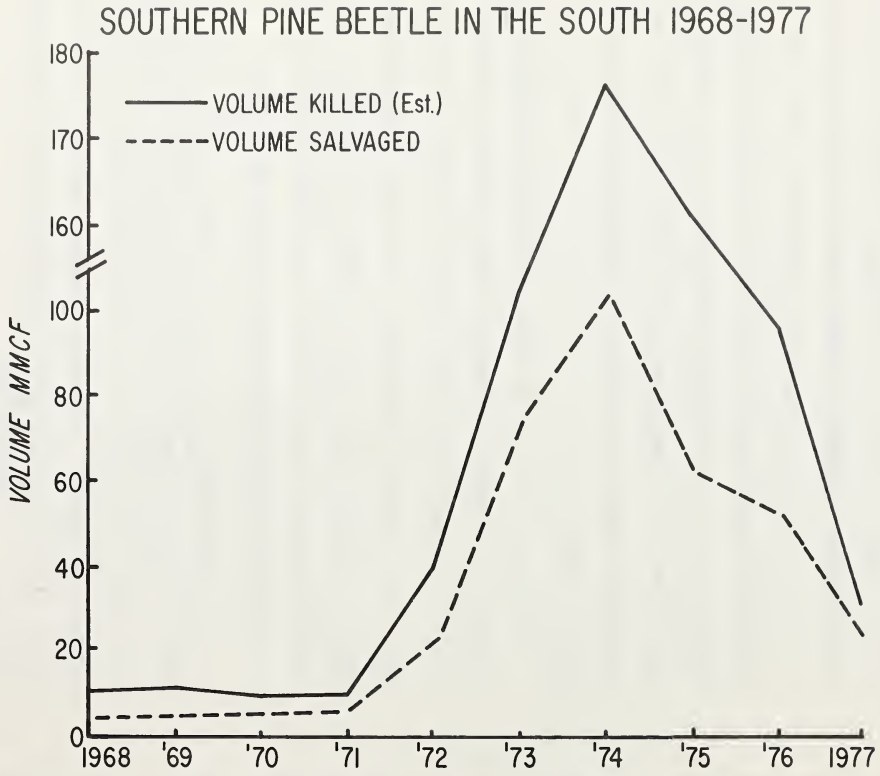
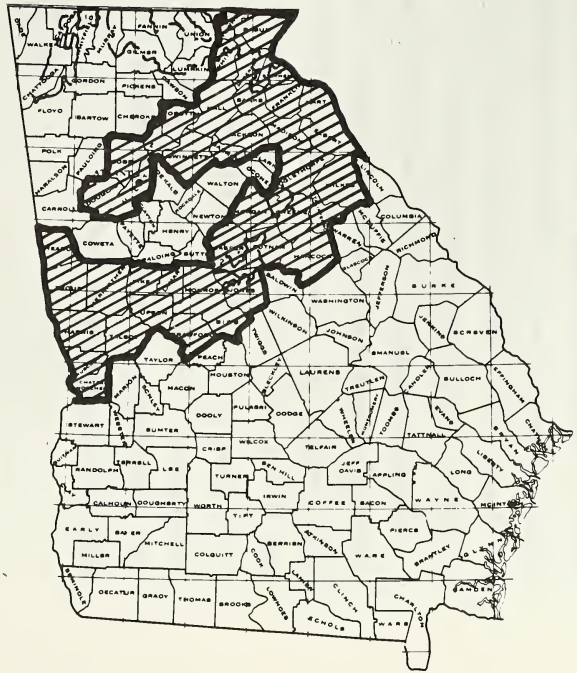


Figure 1. Southern Pine Beetle in the South 1968-1977

Figure 2. Location of Southern Pine Beetle Outbreak in Georgia During the Periods A - 1960 - 1969; B - 1972 - 1976



A

B

The SPB is difficult to control. Under favorable conditions in the Gulf Coastal Plain, there may be seven to eight overlapping generations in a year. Populations build up rapidly. Outbreaks occur as scattered groups of infested trees, making detection and coordination of control programs difficult. Weather conditions may limit accessibility of control or salvage crews. The ownership pattern of southern forests also complicates the problem--over 70% of the acreage is in small private ownership, and forest management objectives on these ownerships vary widely.

SPB control methods in use today focus on direct approaches to reducing timber losses after beetle activity has reached epidemic proportions. Harvesting infested trees (salvage), cut-and-leave, pile-and-burn, and chemical methods can be used to stop individual infestation spread but all are expensive. Salvage has the added advantage in that it helps landowners recover some of the loss. As important as these suppression measures are, they do not provide the forester with lasting means for preventing infestations nor do they reduce damage levels, except in small areas, after outbreaks are underway.

Effective suppression programs must do two things. First, they must lower the incidence of beetle infestations in forest stands. Second, they must reduce the size of infestations after they start. Forest management practices that influence stand density, growth rate, and suitability of particular tree species for specific sites offer promise of decreasing both incidence and severity of beetle infestations. Direct suppression would be reserved for use where infestations reached a size requiring action to reduce damage.

The land manager's need for better ways to reduce damage from SPB led, in 1974, to the Expanded Southern Pine Beetle Research and Applications Program (ESPBRAP). It was one of three accelerated programs undertaken by the U.S. Department of Agriculture; the other programs focused on the Douglas-fir tussock moth in the Northwest, and on the gypsy moth in the Northeast. ESPBRAP projects were funded through the USDA Forest Service and the Science and Education Administration. The six-year Program will terminate on September 30, 1980.

The overall objectives of ESPBRAP are (1) to encourage the use of existing technology to reduce beetle-caused losses, and (2) to develop and evaluate pest management systems to reduce the incidence and severity of outbreaks.

TECHNOLOGY TRANSFER

An applications function was clearly specified for ESPBRAP. This function, known as technology transfer, will receive increasing attention during the Program's final months. Technology transfer activities planned by ESPBRAP include a series of How-To handbooks, workshops, and symposia to stimulate better communications from researcher to researcher and from researchers to practitioners; technical bulletins to synthesize and interpret major areas of SPB research; and newsletters to summarize current research findings.

There are many definitions of technology transfer. The term is sometimes thought to be synonymous with "communications" or "extension of information." But it is more than this. A nationwide Forest Service workshop on technology transfer, held in Tucson in February 1979, suggested a process-oriented definition:

> "Technology transfer is a total process involving: (1) Identification of the technology available for and needing transfer; (2) identification of the target user group(s) to whom the technology or information is to be transferred; (3) development of an objective and formal or informal plan of application; (4) packaging of the knowledge or technology for easy understanding; (5) selection of the media for transfer including seminars, workshops, technical assistance, etc.; (6) direct involvement of scientist and/or specialists with users, especially innovators; (7) troubleshooting and feedback; and (8) evaluation of the process and results."

One of the foremost problems in technology transfer is the communications gap between the researcher and the practitioner. The gap may relate to the researcher's lack of recognition of the "real world" problems of the resource manager, to the form used to communicate new technology to the practitioner, or to the social and physical environment of user groups and organizations.

To bridge gaps between research and applications, ESPBRAP initiated "technology transfer teams."[1/] Each team consists of five to seven individuals representing a cross section of researchers, linkers[2/], and users and deals with a discrete area of new research technology. Their function is to (1) review research in their respective areas, (2) identify additional research and/or application studies needed to facilitate implementation, (3) seek out opportunities for demonstrating, testing, and implementing research, and (4) summarize their recommendations in action plans aimed at accomplishing technology transfer. Eight application areas were proposed for team efforts (see following section on "New Southern Pine Beetle Technology").

1/ USDA Expanded Southern Pine Beetle Research and Applications Program. 1978. Communicating research results to practitioners--A technology transfer plan. Pineville, LA. 12 p.

2/ Linkers are individuals from organizations who have the responsibility and expertise to effectively translate scientific accomplishments into user-oriented terms.

Early on, it was clear that proposed SPB technology transfer activities would benefit from the collective experience of managerial-level persons representing potential linkers and users. Discussions between the ESPBRAP staff and the Resource Protection staff of State and Private Forestry's Southeastern Area led to the formation of the Southern Pine Beetle Technology Transfer Task Force. Because SPB technology transfer activities are expected to continue beyond September 30, 1980, the Task Force will direct its findings and recommendations for followup actions to the Southeastern Area Director of State and Private Forestry.

The general objective of the Task Force is to recommend approaches for stimulating the interest and commitment of land managers to test and utilize the technology produced by ESPBRAP researchers. Priorities for followup activities will be recommended, giving special attention to activities to be initiated before September 30, 1980. The Task Force also will interact with ESPBRAP and S&PF on the makeup of technology transfer teams and the action plans.

The relationship between the Task Force and the ESPBRAP Transfer Teams may be demonstrated by referring to the definition of technology transfer that was previously stated. Responsibility for the eight activities in the technology transfer process may be partitioned between the Task Force and the ESPBRAP Transfer Teams as follows:

Technology Transfer Activity	Task Force	Transfer Teams
1. Identifying technology	X	X
2. Identifying users	X	X
3. Plan of application	X	X
4. Packaging technology		X
5. Selecting media		X
6. Involving users and linkers		X
7. Troubleshooting	X	X
8. Evaluation	X	X

The apparent overlap in activities is not objectionable since the level of involvement of the Task Force and Teams will differ. For example, in reference to activity 3, the Teams are expected to develop detailed action plans for transferring specific technology. The Task Force, on the other hand, will assess the balance among and recommend priorities for the several applications areas.

NEW SOUTHERN PINE BEETLE TECHNOLOGY

Over 75 research and applications projects have been funded by ESPBRAP through 3 U.S. Forest Service Experiment Stations, State and Private Forestry (U.S. Forest Service, Southeastern Area), 2 State forest services, and 12 agricultural experiment stations and universities. More than half of these projects have already been completed or terminated.

A brief discussion os the significant results for each of eight applications areas follows.

1. Silvicultural practices and stand-rating systems.--An extensive Southwide survey of site, tree, and stand characteristice that are associated with SPB infestations has been made. It will serve as the basis for rating susceptibility of stands to beetle attack. The studies show that stand disturbances such as lightning and recent logging activity trigger many infestations. Infestations most often occur in dense older stands with reduced growth rates located on soils subjected to moisture extremes.

Several different stand-rating systems are being developed. By determining values for four or five common field variables (e.g., basal area, growth rate) The forester will be able to determine the relative susceptibility of stands to beetle attacks. Some of these systems are ready for field testing and/or use. They will allow the forester to set priorities for silvicultural treatments and also help nim identify stands that will need special attention when beetle populations begin to increase.

2. Guidelines for utilizing SPB-killed timber.--The mechanical and physical properties of trees killed by SPB have been studied in Virginia, North Carolina, and Texas. Pulpwood-size trees killed by the beetle in the mid-Atlantic States and left on the stump up to 24 months after attack may be safely used as raw material by kraft mills without affecting yield and with only a slight effect on paper properties. Lumber-grade recovery from beetle-killed sawtimber begins to decline 12 months after tree death in Virginia. In the Gulf Coast deterioration is more rapid, and the trees should be utilized for lumber within 6 months.

A sawmill operator's guide (USDA Agricultural Handbook No. 555) has been prepared to show the possibilities for profit in lumber sawn from SPB-killed trees of different sizes and stages of deterioration. Other publications on appearance classes, marketing, and utilization of beetle-killed southern pines are in preparation.

3. Socioeconomic guidelines.--A damage-prediction model, known as FRONSIM, estimates tree mortality for large areas (several counties) for 10-year periods. Historical infestation records, local volume tables, and current timber values are used as input for the model. A stand-growth model (PTAEDA) for plantations and naturally seeded stands allows simulation of the effects of beetle activity and/or management practices on tree growth. PTAEDA provides more precise estimates of growth than FRONSIM. The output of PTAEDA can be used as input to an additional economic model (TBAP) that uses a benefit/cost framework to estimate timber damages and values by landowner class for mixed ownerships.

Effects of beetles on other forest resources--recreation, esthetics, wildlife, grazing, watershed, and fire--can also be estimated.

4. New insecticides and improved spray systems.--Dursban 4E has been approved by EPA for SPB control. This brings to two the number of insecticides that can be used (lindane or BHC is the other). Field work on another insecticide, Sumithion, is nearing completion and, hopefully, will lead to registration.

Much of the insecticide used for SPB control is applied to standing trees in urban areas where spray drift and drift residues are a concern. New spray equipment and spray formulations are being assessed for their capability to reduce drift and drift residues.

5. Sampling methods and predictive models.--Methods for sampling within-tree populations of SPB have been developed and tested in Texas, Mississippi, Arkansas, and North Carolina. A spot-growth model has been developed that estimates tree mortality in spots, given information on beetle numbers, weather, size of trees, and number, etc. It can estimate the relative effectiveness of different control methods. Another model that estimates tree mortality over large forest areas using basal area, brood stage, tree species and radial growth is being field tested in Arkansas.

6. Aerial survey and navigation systems.--A multistage sampling system has been developed for estimating the size and number of infestations and the volume of dead pines. The system combines aerial survey and ground survey techniques and has been pilot tested. Another new aerial system uses digitized data on beetle spot locations, sizes, etc., to keep an accurate record of infestations over relatively large areas.

The accuracy and repeatibility of aerial survey flights has been improved by using LORAN-C radio navigation equipment in survey aircraft. With LORAN-C, flight crews can quickly and accurately retrace previous flightlines or photo points using followup surveys.

Aerial volume tables have been constructed for SPB-killed trees in Mississippi. The tables will be used in estimating annual losses due to the beetle.

7. Behavioral chemicals.--A number of chemical compounds have been isolated and identified from SPB. Both attractants and inhibitors occur in the beetle. These chemicals significantly reduce beetle landing and attack on individual trees but their effect over wider areas needs to be determined.

8. Integrated control strategies.--The development of IFPM strategies is the capstone of the SPB Program. It is also one of the more difficult undertakings since integrated strategies will not necessarily be obvious from the preceding research results. Three types of activities are needed here: (1) An analysis and synthesis of population dynamics, site/stand dynamics, treatment tactics, and impact research results is needed in order to define appropriate IFPM strategies. (2) The strategies must be field tested and refined in cooperation with users. (3) Strategies must be made available in understandable, usable form for implementation by resource managers.

Activities in developing, refining, and implementing IFPM programs are long-term.

OBJECTIVES OF TECHNOLOGY TRANSFER TEAMS

The subject area Transfer Teams will be developing action plans to deal with specific innovations. For their guidance, the general objectives of the respective Technology Transfer team efforts are as follows:

Silvicultural practices and stand-rating systems.--Develop a technology transfer action plan that will stimulate the interest and commitment of forest managers, small private landowners, foresters, and technical specialists to incorporate procedures for preventing or reducing SPB-caused losses into management and harvesting practices and to incorporate SPB-hazard rating considerations into management prescriptions and plans.

Utilization guidelines.--Develop a technology transfer action plan that will inform wood processing plant managers, loggers, sawmill operators, technical specialists, foresters, small landowners, and wood trade associations that trees killed by SPB can be profitably used for several products and to encourage them to salvage more SPB-killed timber.

Socioeconomic guidelines.--Form a technology transfer action plan that will inform forest managers, technical specialists, foresters, and small landowners that impacts of SPB on timber, recreation, wildlife, and esthetic values can be assessed in economic terms and that will motivate these users to perform benefit cost analyses of proposed control programs.

New insecticides and improved spray systems.--Complete a technology transfer action plan that will encourage pest control operators, homeowners, technical specialists, and forest managers to adopt safe and proper use of approved insecticides and spray application methods.

Sampling methods and predictive models.--Develop an action plan for technology transfer activities that will inform technical specialists, foresters, and forest managers that SPB population trends and associated damage can be reliably estimated and that will stimulate the users to adopt sampling and predictive models in order to improve the reliability of pest control decisions.

Aerial surveys and navigation systems.--Develop a technology transfer action plan that will make technical specialists, foresters, and forest managers aware of improved survey methodologies and encourage them to use the new methods to improve the accuracy of detection and evaluation surveys.

Integrated management strategies.--Develop a technology transfer action plan that will make forest managers, technical specialists, and foresters aware of the advantages of integrated forest pest management strategies and that will stimulate user groups to incorporate such strategies into long-term forest management planning.

Behavioral chemicals. Develop a technology transfer action plan to encourage technical specialists and researchers to employ behavioral chemicals in integrated forest pest control programs.

PRIORITY OF APPLICATION AREAS FOR TECHNOLOGY TRANSFER ACTIVITIES

SPB technology transfer activities must compete with other activities and programs of State and Private Forestry, ESPBRAP, the extension services, the State forestry organizations, and forest resource managers/foresters. Allocation of resources to SPB application areas should be made on the basis of (1) urgency of user need for the technology, (2) completeness of research, (3) relative costs and benefits to be derived from the technology, and (4) the degree of uncertainty associated with obtaining the expected results.

Technology transfer activities to be supported by ESPBRAP must be underway prior to October 1, 1980. They will compete for dollars needed for ongoing research and applications activities of the Program. Given these limitations of time and funds, priorities for the eight application areas for technology transfer activities to be supported by ESPBRAP have been established. For the period prior to October 1, 1980, the Task Force recommends the following priorities based on the four criteria above:

High priority

Silvicultural practices and stand-rating systems

Guidelines for utilizing SPB-killed timber

Socioeconomic guidelines

New insecticides and improved spray systems

Medium priority

Sampling methods and predictive models

Aerial survey and navigation systems

Low priority

Integrated management strategies

Behavioral chemicals

Three points need special emphasis with reference to these priority rankings. First, the priorities are for technology transfer activities and not for support of new or ongoing research and applications projects. Second, the priorities pertain to the period ending October 1, 1980. Finally, the priorities do not reflect the relative importance of different lines of work supported by ESPBRAP during the past 5 years. Technology transfer activities are needed in all eight areas, and the Transfer Teams should encourage participation from a variety of organizations. It is expected that high-priority areas will utilize many forms of media and target their activities toward their complete spectrum of users. Medium-priority groups have a more limited user audience in the immediate future and, initially, can use a small array of communications media. Low-priority areas have, at this time, a more limited user audience. There is a need for continuing research activities in these areas, however.

Ranking of the technology transfer areas for priority of activity after October 1, 1980, is very speculative at this point. For FY 1981 and 1982, the priorities will probably not change markedly. But the need for technology transfer will depend on the rate of completion of ongoing work and the effectiveness of the initial transfer activities in promoting user acceptance of the new technology.

Behavioral chemicals and, in particular, integrated management strategies should become increasingly important in technology transfer programs during the next several years. Insecticides and utilization guidelines, on the other hand, may decline in priority as the audiences and users of this technology are made aware of and implement the new practices and guidelines. Silvicultural practices will be a high priority area for quite some time because of the potential importance of this area in preventing outbreaks and the time needed to field test/validate and incorporate such practices into management practices.

PROBLEMS IN TRANSFERRING NEW SOUTHERN PINE BEETLE TECHNOLOGY

To be effective, technology transfer must involve persons in a wide range of disciplines and organizations. The transfer process will encounter problems of four kinds:

1. Those relating to the nature or form of the information or technology itself.
2. Those relating to communication processes.
3. Those relating to organizations in which the desired information or improved technology is expected to take root.
4. Those relating to the personal characteristics of users involved in adoption of the new research.

The Task Force directs attention to the following problems more specific to SPB technology transfer:

1. Many users expect very simple, immediate solutions to the complex SPB problem.
2. There appears to be a reluctance on the part of practitioners to learn new skills needed to implement some of the new technology (e.g., use of sampling methods and predictive models).
3. Interest in adopting new research and control methods subsides when SPB activity drops to low levels.
4. The concept of integrated forest pest management is poorly understood by forest resource managers and landowners in general. Since this concept serves as the framework within which most of the new technology was intended to fit, the application of new technology may be delayed until IFPM is fully accepted and understood.
5. Researchers frequently do not present their scientific results in terms readily understood by practitioners. Also, the researchers often do not become involved in the transfer steps that will translate results into action in a real world setting.
6. Organizations (extension services, State forestry organizations, and State and Private Forestry) with a linker role between researchers and practitioners lack well-defined, long-term plans and commitments to encouraging implementation of new research.

EVALUATING SOUTHERN PINE BEETLE TECHNOLOGY TRANSFER ACTIVITIES

The Task Force recognizes that evaluation is needed at two levels. At one level, the efficacy of the new practice should be evaluated. Social, economic, and ecological considerations vary, and a new practice may encounter unexpected difficulties under operational conditions. There are "bugs" in the first model of every invention. Evaluation on this scale is largely empirical--if a practice continues to fail, it will be discontinued. But resource managers can be a key factor in giving a new practice time and leeway to be refined and adopted.

> "Innovation should be introduced in a way which provides for evaluation as a matter of course, and for the expectation that the first model will not be a finished act; it should be only the beginning of a continuing process which may lead to something much better than the original design."3/

The second level of evaluation is an assessment of the effectiveness of the technology transfer effort in promoting the adoption of the new technology. Technology transfer is concerned not only with the actual implementation of new research, but also with the generation of better strategies for promoting utilization of research. This requires evaluation of previous and new efforts for communicating findings to determine their relative strengths and weaknesses.

Formulating a plan to evaluate the effectiveness of a program on the scale of the SPB technology transfer undertaking is beyond the capabilities of this Task Force. Nevertheless, the Task Force recognizes the importance of evaluating the success of transfer activities.

3/ Putting knowledge to use: A distillation of the literature regarding knowledge transfer and change. 1976. Human Interaction Research Institute. Los Angeles, CA. p. 45.

Three types of evaluation are suggested: (1) Measure accomplishments of individual transfer teams (e.g., completion of tasks by time targets documented in action plans), (2) measure changes in awareness of target user groups toward the technology (e.g., survey a cross-section of users), and (3) measure changes in management practices of target user groups (e.g., incorporation of practices or procedures into management guidelines and practices). The types represent progressively longer-term evaluations. Areas in which long-term evaluation is necessary (e.g., silvicultural practices and stand rating) could be evaluated with the second and third types of evaluations.

Evaluation programs must be organized, documented and implemented early in the transfer effort. Baseline information on the evaluation parameters should be gathered before the transfer activities bring about any alteration of them. Adoption of silvicultural guidelines and integrated management strategies will come about slower than adoption of most of the other application areas. Evaluation of these activities will not be appropriate for many years.

RECOMMENDATIONS

The Task Force finds that ESPBRAP-supported research has produced new information that can be of value to forest landowners in dealing with the SPB problem. We also recognize that there is a considerable amount of knowledge, developed without ESPBRAP support, that has never been effectively utilized by foresters and pest control specialists. Every effort should be made to involve users in the testing and application of findings under operational conditions, to communicate results to potential users, and to encourage the implementation of new technology. The following recommendations should facilitate these efforts:

Recommendation 1.--State and Private Forestry (Southeastern Area) takes on responsibility for coordination of all SPB technology transfer activities. Communicating the various technical innovations must involve the research community, State and Private Forestry, the State forestry organizations, cooperative extension services, Federal land management agencies, and private organizations. State and Private Forestry has well-established lines of communication with the southern forestry community and is in the best position to coordinate a Southwide technology transfer effort. It should serve as a central clearinghouse for assimilating and disseminating SPB technology through a planned series of coordinated activities to ensure that all landowners are made aware of new developments, that needed follow-up activities are undertaken, and that landowners and managers are encouraged to implement the results.

Recommendation 2.--Accelerate activities of State and Private Forestry in SPB technology transfer and in SPB application efforts. Southern forestry organizations cannot afford the lengthy time lags that usually occur between discovery of new methods and their implementation to meet pressing problems in resource management. ESPBRAP was funded as an accelerated Program to provide new or improved approaches for reducing or preventing SPB damages. A "business-as-usual" approach toward communicating, testing and implementing these approaches is not in harmony with the immediate and longer-term needs of users confronted with recurrent beetle-caused losses. State and Private Forestry should place high priority on technology transfer of SPB research results to assure user understanding and implementation in forest management programs.

Recommendation 3.--Utilize *ad hoc* technology transfer teams to accomplish SPB technology transfer activities. *Ad hoc* technology transfer teams, as initiated by ESPBRAP, should continue to review accomplishments and recommend activities in the several application areas. Each team will normally consist of five to seven individuals representing a crossection of researchers, linkers, and practitioners. The number of teams, as well as the number of members on a team may change in the future to reflect changes in priorities based on accomplishment and state of implementation.

Recommendation 4.--Establish general priorities of technology transfer activities for the several applications areas and periodically reassess priorities. For the initial technology transfer activities, high-priority areas are (1) silvicultural practices and stand rating systems, (2) guidelines for utilizing SPB-killed timber, (3) socioeconomic guidelines, and (4) new insecticides and improved spray-systems. Medium-priority areas are (1) sampling methods and predictive models, and (2) aerial survey and navigation systems. Low-priority areas are (1) integrated management strategies, and (2) behavioral chemicals. With further accomplishment in ESPBRAP, and based on recommendations of the transfer teams and the coordinating council, priorities should be reassessed shortly before the termination of ESPBRAP and periodically thereafter.

Recommendation 5.--Establish a coordinating council to periodically review activities of SPB technology transfer teams. The council should be constituted in the same manner as was this Task Force, i.e., participants represent a middle-management crossection of the State, Federal and private forestry organizations concerned with the SPB problems. In the beginning, the council should meet annually with the several transfer teams to review progress and problems and then meet in executive session to prepare summaries and recommendations. Council reports are to be submitted to the Southeastern Area Director, State and Private Forestry.

Recommendation 6.--Encourage Federal, State and private forestry organizations to implement new procedures into management practices regardless of the prevailing level of SPB damage. Many of the findings from ESPBRAP-supported work for dealing with SPB are both preventive and long-term in nature (e.g., stand ratings, silvicultural manipulations). Some of the approaches still require local or regional verification under operational conditions. These practices should be installed immediately in areas that have a chronic history of SPB damage.

Recommendation 7.--Develop immediately and implement procedures for evaluating the effectiveness of the overall SPB technology transfer program in promoting the adoption of new technology. Expertise in organizational behavior, human behavior, operations research, research administration and technology transfer should be contracted for the purpose of designing a detailed SPB technology transfer evaluation plan that includes procedures for evaluating the technology transfer process and establishes a time table for accomplishing evaluations. The plan should be set in motion, on a continuing basis, in FY 1980. It could serve as a pilot program for developing long-term continuing processes for evaluating State and Private Forestry technology transfer efforts in all fields of endeavor.